# Sovereign debt auctions: Uniform or discriminatory?

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## ARTICLE INFO

## ABSTRACT

Many financial assets, especially government bonds, are issued by an auction. An important feature of the design is the auction pricing mechanism: uniform versus discriminatory. Theoretical papers do not provide a definite answer regarding the dominance of one type of auction over the other. We investigate the revealed preferences of the issuers by surveying the sovereign issuers that conduct auctions. We find that the majority of the issuers/countries in our sample use a discriminatory auction mechanism for issuing government debt. We use a multinomial logit procedure and discriminatory analysis to investigate the mechanism choice. It was interesting to find that market-oriented economies and those that practice common law tend to use a uniform method while economies who are less market oriented and practice civil law tend to use discriminatory price auctions.

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## 1. Introduction

There is a long-standing debate regarding the auction system that a sovereign should use when it issues debt instruments. The most common pricing rules are the uniform and the discriminatory.[1] Our objective is to analyze the choices made by countries around the globe and what may explain these choices.

As early as 1960, Friedman has argued that a discriminatory auction will drive out uninformed participants because of the "winner's curse" and attract better informed, typically large players. Thus, the discriminatory auction will be more susceptible to collusion than the uniform one. He predicted that the discriminatory auction would lead to lower revenues. Alternatively, a uniform price mechanism would lead to wider participation which should result in lesser collusion and higher revenues. It is puzzling, therefore, to find that most countries, in our study, use the discriminatory price mechanism.

The academic literature since Friedman (1960) is not conclusive regarding the optimal pricing mechanism that countries should use in sovereign debt auctions. Both pricing mechanisms are used in practice. Also, several countries, in our sample, switched from one pricing rule to another (see, for example, the US experiment).[2]

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  [1] In the **uniform price auction (UPA) (also known as single price auction)**, the objects are awarded to bidders that bid above the market clearing price. All bidders pay the (same) market clearing price. In the **discriminatory auction (DA) (also known as multiple prices auction)**, the objects are also awarded to bidders that bid above the clearing price but each bidder pays the price that he bid.
  [2] The so-called "Salomon Squeeze" in May 1991 (Jagadeesh, 1993) has triggered an examination of the auctioning system, in particular the pricing rule. Though the experiment did not result in a significant revenue improvement in the uniform auction versus the discriminatory, there were additional considerations in the decision to switch to the uniform auction (Malvey et al., 1995; Malvey and Archibald, 1998).

Our research consists of two parts. First, we document the recent auction mechanisms employed by treasuries and central banks around the globe (their revealed preferences). In the second part, we analyze, in a cross-sectional setting, the factors that are potentially related to the choice of a mechanism by country. We use several variables that were used in the academic literature to study the relationship between financial development and economic growth. Given our results we provide an explanation, consistent with our empirical finding that takes into account the bargaining power of the three stake holders; the issuer, the intermediaries and the investors.[3]

Though the primary market for government debt is one of the largest financial markets in the world, there is no source of public data that provides information about treasury auctions. This information can only be obtained by collecting data directly from each country. We have contacted treasury ministries and central banks around the globe and received answers from 48 countries. We have screened this unique data and documented which country is using what mechanism (discriminatory, uniform, both or other pricing rule). Our sample consists of countries from different continents and economic size, including almost all (83%) OECD countries.

Most countries use a discriminatory auction (24) while nine countries use a uniform auction. Some use both mechanisms (9), depending on the security being auctioned, while others use pricing rules which are neither uniform nor discriminatory (6). We investigate the factors which may explain the choice of an auction mechanism by a sovereign. We find that countries that have more market-oriented economies (as measured by capitalization/GDP) and practice common law tend to use a uniform price auction. In other countries where the financial environment is less developed and barriers to the public's participation in the auctions (direct or indirect) may exist, the central planner needs to be more attuned to the preferences of the intermediaries and if they prefer a discriminatory price auction the central planner will adopt this mechanism.

Our paper belongs to the growing literature on divisible-unit auctions. The theory does not tell us whether the uniform auctions will generate higher revenue than the discriminatory ones.[4] This remains an empirical issue that our research is trying to contribute to. The relevant empirical work uses either an event study approach (e.g. the US experiment)[5] or employ structural econometric models.[6] The novelty of our approach is the application of a cross-section analysis to find explanatory variables for sovereign decisions.[7] It makes a contribution to the literature on the relationship between country characteristics and financial development.

The paper is organized as follows. Section 2 looks at the auction practices of different countries. Section 3 investigates the factors that affect a country's choice. Section 4 provides concluding remarks.

## 2. Auction methods used by issuers of government bonds

We first investigated the current practices used worldwide at treasury auctions. Since this information is not available in public databases, we had to use our own survey which was sent (see Appendix A) via e-mails, mail and faxes to central banks and treasuries around the globe.[8] We received answers from 48 countries, listed in Table 1.

The responses that we have received show that 50% of the countries use a discriminatory price auction, about 19% use a uniform one while about 19% use both methods, depending on the type of debt instruments being issued. The others, about 12%, use a method that is different than the two conventional ones (e.g. Austria). Interestingly, even among countries with the same currency and relatively similar monetary policy (for example, the EU countries that use the Euro) different types of auction mechanisms are used. Finland, for example, which used a uniform price mechanism, does not use auctions anymore[9] while France and Germany use a discriminatory auction. We also find that in some countries the mechanism that is being used has changed over time (e.g. the US has switched, in the 1990s, from a discriminatory mechanism to a uniform one while Mongolia switched from uniform auction to a discriminatory one). In about 50% of our sample, the country employed in the past a different selling mechanism than the one it currently uses. Some countries in our sample use more than one type of pricing rule to sell their debt instruments (e.g. Canada and Brazil). Some use a different auction mechanism to issue debt than to buy back debt (e.g. USA).[10] Given the different practices and the changes introduced by

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[3] The objective of the issuer, the treasury or the central bank, is to maximize revenues over time. The issuer is not only concerned with the next auction's revenues but has also long-term considerations, like the development of the secondary market and the likelihood of collusion in the auction or the secondary market. The goal of the intermediaries, who serve as underwriters, dealers and brokers, is to maximize the profit from their activities. The third stakeholder is the public, including financial institutions, who invest in these debt instruments and would naturally like to pay the lowest possible price.

[4] See, for example, Wilson (1979), Back and Zender (1993) and Ausubel and Cramton (2002) for theoretical evidence on strategic bidding in multiunit auctions.

[5] The main issue with this approach (see in addition Tenorio, 1993; Umlauf, 1993) is that one cannot claim "ceteris paribus" that the economic conditions have not changed.

[6] These papers (e.g. Hortaçsu, 2002) use a bidder's optimality condition to recover the distribution of the marginal valuations of the bidders. At its current stage, this literature does not provide a clear answer with respect to the mechanism choice.

[7] A previous cross-country description of auction design issues is given in Bartolini and Cottarelli (1997). While their paper describes various aspects of the auction mechanism, our paper investigates recent practices and focuses on the determinants of the choice of the auction pricing rule.

[8] The survey was sent to all the central banks that their e-mails were listed at the bank for international settlements, international directory and to the treasuries and central banks that their e-mails were listed at the IMF home page. In some cases, when we did not get a response, we used personal contacts to get answers to the survey.

[9] Though it now considers reinstating them in the future.

[10] See Han et al. (2007) for the description of the US treasury buyback auctions.

**Table 1**
Survey answers regarding the type of auctions used to sell sovereign debt in different countries around the world as of April–October 2005.

| Discriminatory | Uniform | Both | Other |
|---|---|---|---|
| Bangladesh+ | Argentina | Brazil | Austria+ |
| Belgium+ | Australia | Canada+ | Finland+[a] |
| Cambodia+ | Colombia | Ghana | Luxemburg |
| Cyprus+ | Korea+ | Italy | Fiji+ |
| Ecuador | Norway | Mexico+ | Ireland+ |
| France | Singapore | New-Zealand+ | Japan |
| Germany+ | Switzerland+ | Sierra—Leon+ | |
| Greece+ | Trinidad and Tobago | Slovenia | |
| Hungary | USA+ | United Kingdom+ | |
| Israel+ | | | |
| Jamaica | | | |
| Latvia+ | | | |
| Lithuania+ | | | |
| Macedonia | | | |
| Malta± | | | |
| Mauritius | | | |
| Mongolia+ | | | |
| Panama+ | | | |
| Poland+ | | | |
| Portugal+ | | | |
| Solomon Islands | | | |
| Sweden+ | | | |
| Turkey+ | | | |
| Venezuela | | | |

The table describes the auction mechanism employed by the countries in our sample. + Indicates if the treasury or the central bank has the right to change the quantity being auctioned. For more details about the specific auction in each country, see Appendix A.

[a] At the time of the survey, Finland indicated that it does not use auctions to sell its debt. Yet after the survey was conducted, we received information that Finland considers using again uniform auctions in the future.

some countries[11] it is clear that research, theoretical, experimental and/or empirical, about auction designs would be of great interest to a variety of issuers, be it governments or corporations. Thus, we examine the features which make up the profile of a country to see if there are common factors associated with one auction design or another.

## 3. What may affect the choice of an auction mechanism by a country?

Given the potential consequences of the mechanism choice on the revenue obtained and the subsequent activity in the secondary markets, we investigate the possible factors that may affect this choice. As stated above, the cross-section analysis, done for the first time, looks for specific characteristics that affect the mechanism choice. There is no auction related model that provides specific guidelines as to the variables that we should include in the empirical investigation. We have decided to use a set of macro variables that have been used in studying macro finance issues and seemed to be appropriate in our context.

The first set of variables is related to the risk of the assets that are being auctioned, more specifically the credit risk of the sovereign. Anecdotal evidence from the UK (Leong, 1999) suggests that the UK took into account the potential level of the "winner's curse", due to the riskiness of the asset auctioned, in its determination of the auction price mechanism. The second set of variables is related to the specific characteristics of the country that issues the debt and the characteristics of its financial markets. We, thus, examined the recent literature which investigates the different global financial systems, trying to explain their growth and efficiency by their legal system and other economic and non-economic variables. La Porta et al. (1998), Levine (1999) and others, argue that legal systems that protect creditors and enforce contracts are likely to encourage greater financial intermediary development than legal and regulatory systems that ineffectively enforce contracts. Following this literature, we use the origin of law as a potential explanatory variable to the auction mechanism design. Rajan and Zingales (1998, 2003) discuss how to measure financial development and suggest that the measures should capture the ease with which any entrepreneur, company or country can raise funds and the confidence with which investors anticipate an adequate return. Allen et al. (2006) find a link between the economic system and the financial system. Here we use two variables: capitalization divided by GDP and the ranking of "easiness of doing business". There is growing literature that connects different aspects of political forces to the structure of financial markets. Examples include Perotti and von Thadden (2006), Pagano and Volpin (2001, 2005), Bolton and Rosenthal (2002) and Biais and Perotti (2002)

[11] We also found that most countries using both mechanisms have the right to change the quantity after viewing the bidding results (67% for the discriminatory and 56% for the uniform), yet some of them do not use this right.

among others. Given this literature, we collected data that include indexes that rank different countries by freedom of the economy and the level of corruption.[12]

### 3.1. Data sources (explanatory variables)

We collected several explanatory variables that describe the auctioned assets and the issuer, from the World Bank and its International Finance Corporation (IFC), Moody's, the Wall Street Journal and Transparency International.

For the specific characteristics of the bonds being auctioned, we use an estimate of the sovereign default risk. We use Moody's sovereign debt ratings (August 2005) and World Bank Indebtedness Classification (2003).[13] The rationale for investigating the effect of sovereign risk on the mechanism choice is the potential relationship of risk and the "winner's curse".

We also include variables that describe the legal system, the financial structure and the economic environment of the countries that issue the debt. The legal system of countries can be classified either as civil (Roman) law or as common law. Common law is associated with countries that have a more liberal economic system, small role for the government like Britain, the United States and Australia, while civil law is associated with economies where the government plays a larger role like France, Germany and Japan. Stock market capitalization as percentage of the GDP (World Bank—2003) serves as a proxy for the degree of development of the financial markets while GDP (World Bank—2003) itself serves as proxy for country size.

We also use several indexes that rank the level of competitiveness, economic freedom and corruption. The ease of doing business 2006 index (*source*: IFC) ranks countries on their ease of doing business from 1 to 175. A high ranking means the regulatory environment is conducive to the operation of business. The CPI Corruption 2005 Index (*source*: Transparency International) aims to measure the overall extent of corruption (frequency and/or size of bribes) in the public and political sectors. The index ranks countries from 1 to 158. The Index of Economic Freedom 2006 (*source*: The Heritage Foundation/Wall Street Journal) uses 50 independent variables divided into 10 broad factors of economic freedom to rank 161 countries.

### 3.2. Empirical findings—a univariate investigation

We divided our sample into three categories according to the pricing mechanism, those that use the discriminatory auction, those that use the uniform auction and those that use both. Table 2 provides the means and medians of these variables with respect to the auction mechanism.

First, we find that countries that use a discriminatory auction have, on average, significantly lower capitalization to GDP ratio compared with countries that use a uniform auction ($P = 0.03$) and countries that use both ($P = 0.04$). There is no significant difference in the averages of this ratio between countries that use both mechanisms and those that use the uniform one. Second, we find that the type of law practiced in countries that use a discriminatory auction is significantly ($P = 0.038$) different than the legal system in countries that use a uniform auction. Specifically, we find that countries that use a discriminatory auction tend to be countries with a civil law system.[14] Third, we do not find GDP to be significantly different between countries that use the discriminatory auction and countries that use the uniform one. Fourth, though we find the frequency measure of indebtedness classification to be higher for countries that use a discriminatory auction compared with those that use a uniform one, the difference is only marginally significant.[15] Fifth, we find, using a standard non-parametric test that the ranking of ease of doing business Index is significantly higher for countries that use a uniform auction than those that use a discriminatory one. Though we find that a lower corruption index level and a higher level of economic freedom index are associated with countries that employ a uniform auction compared with the discriminatory one, these differences are not statistically significant.

In summary, the univariate investigation indicates that variables associated with development of financial markets, capitalization to GDP, ease of doing business and the type of law employed, are statistically significant.

### 3.3. A multivariate investigation—multinomial logit and discriminatory analysis

To examine which variables affect the mechanism choice, we also conducted a multinomial regression analysis.[16] Our dependent variable, the auction mechanism, was classified into four categories: uniform, discriminatory, both types, other

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[12] While we would like to have additional variables such as the number of participants in the auction markets and their relative share in dollar terms, this information is not only unavailable to us but is also unavailable to most issuers (e.g. central banks and treasuries) since the buyers may represent also other participants. For a discussion on data issues see Fleming (2007).

[13] In 2003, countries with a present value of debt service greater than 220% of exports or 80% of GNI were classified as severely indebted, countries whose present value of debt service exceeded 132% of exports or 48% of GNI were classified as moderately indebted and countries that did not fall into either group were classified as less indebted.

[14] The same applies to the difference between countries that use a discriminatory auction versus countries that use both types of auctions.

[15] Moodys rating of over 60% of the countries that use the uniform price mechanism is Aaa. This is true only for 17% of the countries that use the discriminatory mechanism.

[16] Multinomial logit models are an extension of logistic models for more than two alternatives.

**Table 2**
Sovereign classification by auction method and by country characteristics.

| | Discriminatory ($N = 24$) | Uniform ($N = 9$) | Both ($N = 9$) |
|---|---|---|---|
| % Of civil law | 83[a] | 44% | 43% |
| Average stock market capitalization % of GDP | 38%[b] (std = 32%) | 97% (std = 69%) | 54% (std = 42%) |
| Median stock market capitalization % of GDP | 28[c] | 101 | 42 |
| Average GDP | 2.49E+11 (std = 5.80E+11) | 1.43E+12 (std = 3.56E+12) | 5.54E+11 (std = 6.36E+11) |
| % Of indebtedness classification | 67[d] | 33 | 44 |
| Average ranking of ease of doing business | 56[e] | 25[f] | 62 |
| Median ranking of ease of doing business | 52[g] | 11[h] | 70 |
| Average ranking of corruption index | 61[i] | 33 | 44 |
| Median ranking of corruption index | 51[j] | 17 | 40 |
| Average ranking of economics freedom index | 55[k] | 39 | 51 |
| Median ranking of economics freedom index | 44[l] | 30 | 42 |

This table provides descriptive statistics of the countries according to the auction mechanism employed by them and the country classification on several dimensions; *indebtedness classification*, The World Bank (*source*: 2003) classifies countries by their level of indebtedness for the purpose of developing debt management strategies. It uses a three-point scale: severely indebted (S), moderately indebted (M) and less indebted (L). The indebtness classification serves as proxy for the riskiness of the country. *Civil* (*Roman*) *law* versus *common law*. This variable was proposed by La Porta et al. (1998). *Stock market capitalization as percentage of the GDP* (*source*: World Bank—2003). Market capitalization is the share price times the number of shares outstanding.
*GDP* (*source*: World Bank—2003) is measured in current US$. *Ease of doing business 2006*. (*source*: IFC—published in 2005). The ease of doing business index ranks economies from 1 to 155. *The CPI corruption index 2005* (*source*: Transparency International) aims to measure the overall extent of corruption (frequency and/or size of bribes) in the public and political sectors. The index ranks countries from 1 to 158. *The index of economic freedom* 2006 (*source*: the Heritage Foundation/Wall Street Journal). The index uses 50 independent variables divided into 10 broad factors of economic freedom to rank 161 countries.

[a] Based on 23 observations since we do not have the classification for the source of law of Solomon Islands.
[b] Based on 19 observations since data were not available for Cambodia, Macedonia, Malta, Cyprus and Solomon Islands.
[c] Based on 19 observations since data were not available for Cambodia, Macedonia, Malta, Cyprus and Solomon Islands.
[d] Based on 21 observations since data were not available for Malta, Cyprus and Solomon Islands.
[e] Based on 22 observations since data were not available for Malta and Cyprus.
[f] Based on eight observations since data were not available for Trinidad and Tobago.
[g] Based on 22 observations since data were not available for Malta and Cyprus.
[h] Based on eight observations since data were not available for Trinidad and Tobago
[i] Based on 23 observations since data were not available for Solomon Islands.
[j] Based on 23 observations since data were not available for Solomon Islands.
[k] Based on 23 observations since data were not available for Solomon Islands.
[l] Based on 23 observations since data were not available for Solomon Islands.

types (Beck et al., 2000). We estimated four different models with a different set of independent variables. In Table 3, we present the values of the coefficients and the statistical significance only for the comparison between the uniform auction and the discriminatory one.

Our main finding is that capitalization/GDP is positively and significantly correlated with the choice of a uniform auction, rather than the discriminatory one. The dummy variable for civil law versus common law is significantly correlated with the bidding system.[17] Neither GDP by itself nor the dummy for indebtedness classification are significantly correlated with the mechanism choice.[18]

For robustness, we also conducted a discriminatory analysis that is used to classify cases into categorical dependence. The results that we obtain are consistent with our multinomial logit results. We find that we can correctly classify 82% of the observations using only the capitalization/GDP ratio. Moreover, adding other variables from our list does not improve our ability to classify (Wilks' Lambda test is significance at 0.007).

Why does the financial markets development factor play such an important role in the auction design decision of the issuer? Why countries with less developed financial markets choose the discriminatory auction? Our conjecture is related to the bargaining power of the different financial players in the market. In many countries, the issuer cannot rely on sufficient (at a desirable minimum price) direct investor participation and needs the help of the intermediaries to sell the issue. If the intermediaries prefer a discriminatory auction, then the issuer has an incentive to use this auction system.[19] Why would dealers/intermediaries prefer a discriminatory mechanism? One possible explanation is that this mechanism does not result in one known equal price to all investors, which helps them to sell it at a higher price in the secondary market. Another possible explanation relates to Friedman's argument that the discriminatory mechanism reduces the

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[17] When the two variables are used together, only capitalization/GDP remains significant. This could be due to multicolinearity; the Pearson correlation between these two variables; legal system and capitalization/GDP ratio is −0.354 which is significant.
[18] We also examined the choice between using both mechanisms versus using only the discriminatory one. The only variable that is significant and negatively correlated with the decision to use "both" mechanisms rather than the discriminatory one is the dummy variable for civil law.
[19] For part of our sample, we were able to collect the total size of government debt and indeed those countries that use a discriminatory price mechanism have on average larger government debt to GDP ratio.

**Table 3**
What explains auction type choices—multinomial analysis.

| Variables | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Constant | −2.572** | −0.503 | −0.110 | −1.535 |
| | (−2.995) | (−0.765) | (−0.154) | (−1.233) |
| Cap/GDP | 0.030** | – | – | 0.025** |
| | (2.579) | – | – | (2.075) |
| Dummy (indebtedness classification) | – | −1.069 | – | – |
| | – | (−1.085) | – | – |
| GDP | – | 3.66e−13 | 7.60e−13 | – |
| | – | (0.847) | (1.459) | – |
| Dummy (civil law) | | | −1.823** | −1.140 |
| | | | (−2.020) | (−1.071) |
| Pseudo $R^2$ | 0.096 | 0.106 | 0.088 | 0.126 |
| Prob $> \chi(n)$ | 0.023** | 0.069* | 0.115 | 0.057* |

For completeness and statistical accuracy, we conducted a multinomial analysis that included four auction categories: uniform, discriminatory, both and other mechanisms. We present here only the comparison between the uniform and the discriminatory mechanism. The discriminatory mechanism is the comparison group. The dependent variables are as follows: a dummy for *indebtedness classification* (*source*: World Bank—2003). *Civil* (*Roman*) *law* versus *common law* variable was proposed by La Porta et al (1998). We try to see whether the auction mechanism is associated with the legal system in a country. *Stock market capitalization as percentage of the GDP* (*source*: World Bank—2003). *GDP* (*source*: World Bank—2003) is measured in current US$. Z values are in parenthesis. We estimated four different specifications as follows.
** Significant at 5% level.
* Significant at 10% level.

number of potential bidders and hence the number of potential competitors which could result in them paying lower prices. A study by Sade et al. (2006) has shown that in the discriminatory mechanism, on average, the participants collude more and pay lower prices. On the other hand, in countries with well developed financial markets, the intermediaries have less bargaining power in setting the auction mechanism since the central planner can rely on public participation.[20] Given the intermediaries assumed preferences on one hand, the investors/public assumed preferences on the other hand and the issuer's objective, it is clear why the bargaining power between the three different stakeholders may affect the auction's mechanism choice.[21] To provide additional support to our conjecture that bargaining power may drive the observed results, we searched for a proxy for the relative power of the dealers. A suitable proxy, in our opinion, is the level of concentration of the banking system. In many countries, not in the US, the commercial banks serve as the dealers in the bond market. Thus, the higher the concentration the higher is their bargaining power. We use the 2004 bank concentration measure from the updated version of "New Database on Financial Development and Structure" by the World Bank constructed by Beck, Demirgüç-Kunt and Levine. Their bank concentration measure is calculated as the value of the assets of the three largest banks as a share of all commercial banks assets in the country. For each auction mechanism, we counted the number of countries that the concentration value is above the median of all countries in the sample. We divided this number by the total number of countries that use the respective mechanism. We find that in the sample of countries that use the discriminatory mechanism there is a higher proportion of countries that their concentration level is above the sample median (0.55) while this ratio is lower for countries that use the uniform one (0.44).[22]

Finally, for whatever it is worth, we would like to import the following quote made in reference to the Treasury's move from a discriminatory auction to a uniform one:

> But some primary dealers responded to the Treasury's trial balloon last week by saying that nobody will bid for these bonds at a Dutch auction. Are they wrong? WSJ/Diana B. Henriques; Treasury's Troubled Auctions, 1991.

## 4. Summary and conclusions

In auctioning financial assets governments face a major decision; what is the optimal pricing mechanism to sell their debt? Should it be a uniform price auction or a discriminatory one? The existing theoretical and empirical work is ambivalent about the method that a sovereign should use.

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[20] An argument, consistent with this conjecture, is made by Brenner et al. (2007) in an experimental study. They show that when investors are given the choice between a uniform auction and a discriminatory one, they prefer to participate in a uniform auction and are willing to pay higher prices. It is suggested that a possible reason for such a preference is that uniform auctions are perceived as "fair" and transparent by the participants. See also Garbade (2004) for the description of the 1959 testimony by Robert Anderson, Secretary of the Treasury, who suggested that small banks, corporations and individuals do not have the "professional capacity" to bid at the discriminatory auction.

[21] It could be argued that the main consideration in choosing a discriminatory auction in the US Treasury buy back program is the dealers bargaining power.

[22] Though this result is statistically insignificant, possibly due to the sample size, it supports our conjecture.

We find that most countries use the discriminatory method, and fewer use the uniform one. We also find that most market-oriented economies use the uniform price mechanism and that countries that use the uniform price mechanism tend to be "common law" countries and have, on average, a more favorable ranking for "easiness of doing business", economic freedom and have a lower level of corruption. Using multinomial analysis, we find that capitalization/GDP is correlated with the mechanism choice. This is supported by a discriminatory analysis.

So why do we find so many countries using the discriminatory pricing method? Our conjecture is that the financial markets in many of these countries are dominated by a few large financial intermediaries and it is in their interest, paying lower prices, to have a discriminatory auction rather than a uniform one. These few institutions are better informed than the rest of the public because they hold a large portion of the potential bids either as proprietary bidders or as agents for other bidders. This conjecture is supported by our tests that show that the discriminatory method is used more in countries which have less developed financial markets.[23]

Future research should use additional variables to investigate further the linkage between auction design, financial markets and economic variables; why so many countries use the discriminatory method. The effect of the secondary market on auction design is an interesting topic and so is a study about the switch that some countries have made, from one auction type to another, the reasons behind it and the consequences of it.

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## Appendix A. Supplementary data

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jmoneco. 2008.12.012.

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[23] An additional explanation for the origin of using a given rule method has to do with the evolution of financial markets around the globe. Since the development of financial markets around the globe has, by and large, lagged behind the US many countries have just followed the pre-change US example without questioning its rationale and whether it is appropriate and fits the market structure of that country.

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